# FIELD STUDY GUIDE

to

# BIOTIC COMMUNITIES OF THE CENTRAL ATLANTIC REGION

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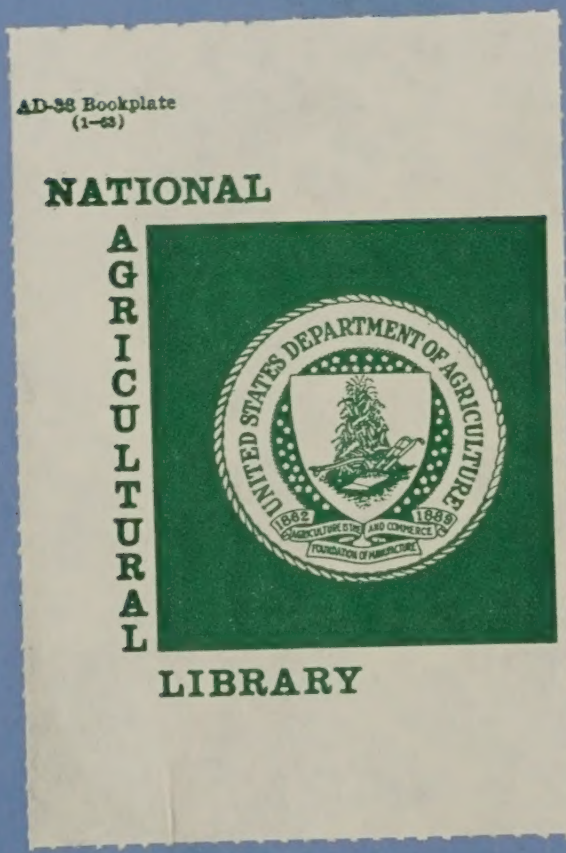
The contents were prepared for use in two courses in the Natural History Field Studies Program of the Graduate School, USDA, conducted in cooperation with the Audubon Naturalist Society of the Central Atlantic States:

E1138 Biotic Communities: I. Deciduous Forests
E1141 Biotic Communities: II. Coniferous Forests

Descriptive material and regional literature cited pertain to the Central Atlantic Region; roughly, the area within a day's driving distance of Washington, D. C., extending from the Atlantic shore to the backbone of the Allegheny Mountains.



Contents

# I. GUIDE TO FIELD STUDY OF AN ECOSYSTEM

This guide suggests essential points in the field analysis of any land area and its biotic community as an ecosystem and gives some standards for evaluating and describing features of the environment and biota.

A natural ecosystem cannot be completely described or understood from a single visit, or even from study in one season. A thorough analysis requires intensive studies of different features at different times, followed by synthesis of the information into an integrated concept of the ecosystem as a whole.

This guide and the related worksheets can be used for a continuing study of an area or for summarizing such information as can be obtained from a cursory survey. In making a single field examination, it is advisable to proceed with the topics in the order listed. Information on A, General Environment, can usually be assembled in advance from reference material and general observation. Appraisal of B, Biota, and C, Local Habitat, requires detailed field observations. These findings lead to an interpretation of the biotic community in relation to the physical features of its environment.

## A. GENERAL ENVIRONMENT

1. Climate

Identify the climatic type as defined by moisture and temperature:

Moisture -- Wet, Humid, Subhumid, Semarid, and Arid.

Temperature -- Hot (tropical), Warm (temperate), Cool (temperate), Cold (Taiga), Tundra, and Permanent Frost.

(BLUMENSTOCK, B. I., and THORNTHWAITE, C. W., 1941, "Climate and the world pattern," in USDA Yearbook, Climate and man, pp. 98-127.)

Record mean annual values for rainfall, temperature, and growing season. (U. S. Weather Bureau records; USDA Yearbook 1941, Climate and man; VOKES, H. E., 1961, Geography and geology of Maryland.)

2. Physiographic Area

Identify the general physiographic area by an accepted classification. The major divisions (provinces) usually recognized in the Central Atlantic Region are: Coastal Plain, Piedmont Plateau, Blue Ridge, Appalachian Ridges and Valleys, and Allegheny Plateau. (FENNEMAN, N. M., 1938, Physiography of eastern United States, McGraw-Hill, New York, 714 pp. The U. S. Soil Conservation Service uses classification of Land Resource Areas that further subdivides these provinces on the basis of soils, climate, and other natural features; see AUSTIN, MORRIS E., 1965. Land resource regions and major land resource areas of the United States. U.S.D.A., Agr. Hbk. 296. 82 pp., map.)

3. Regional Climax

Identify the regional (climatic) climax biotic association or type according to the classification used in Sec. B, Biota.

## B. BIOTA

To make an inventory of the biota and analyse the community structure in a single visit, first complete the worksheet, "Composition and Structure of Biotic Community", in three steps: (1) Walk over the area to observe larger animals that might be frightened away by your presence; (2) Search for smaller animals and all kinds of evidence of animal occurrence; and (3) Inventory and estimate abundance of plants. From this information, appraise the community as a whole and draw conclusions about its climax and successional status.

### 1. Composition

Make as complete a list as possible of plants and animals living on or using the area (see worksheet, "Composition and Structure of Biotic Community"), and group them according to their ecological functions as follows:

Producers -- Green plants. Can be further grouped by life form as trees (canopy and understory), shrubs, vines, grasses, and forbs.

Consumers -- Animals. May be further grouped as:

Herbivores (Primary consumers). Animals that feed directly on plants or plant products.

Primary predators (Secondary consumers). Animals that feed on herbivores.

Secondary or top predators (Tertiary consumers). Animals that feed on primary predators.

Omnivores. Animals that feed about equally on plants and other animals.

Parasites. Animals that feed on live animals without killing.

Saprovores and Scavengers. Animals that feed on dead plants or animals.

Decomposers. Organisms that live on dead organic material, breaking it down into its inorganic components.

### 2. Abundance

Indicate for each species some measure or estimate of relative abundance or density, based either on general observation and judgment or on systematic estimates, counts, or measurements. Many techniques are available for this purpose, suitable in varying degrees to different species. (CAIN, S. A., and CASTRO, G. M. de O., 1959, Manual of vegetation analysis, Harper and Bros., New York, 325 pp.)

In the absence of more specific census or measurement techniques, the following abundance classes may be applied by judgment to either plants or animals:

Rare or scarce. An isolated observation, or less than 10% frequency on a series of sample plots; not ecologically important.

Occasional. A few observations, 10-35% frequency; slightly important.

Common. Several observations, 35-65% frequency; moderately important.

Abundant. Numerous observations, 65-90% frequency; of major importance.

Very abundant. Generally prevalent, 90-100% frequency; practically monopolizing its ecological role.

### 3. Dominance

Designate the plant species that are dominant and subdominant in the community, either as a whole or by structural layers (canopy, understory, shrubs, herbs, etc.) Dominants in a subordinate layer are seldom more than subordinants in the community as a whole. Data on abundance (density, coverage, biomass, basal area, etc.), converted to percentages of total composition, provide an arbitrary guide to dominance, as follows:

Dominant -- Those species individually most abundant which, taken together, comprise more than 50 percent of the composition.

Subdominant -- Those species that are not dominant but which individually comprise 10 percent or more of the composition.

4. Climax of the site

From the inventory and analysis of the plant and animal populations comprising the community, identify the edaphic or local climax of the site according to some published or agreed-upon system of classification, or by naming the species believed to be dominants of the climax. (SHELFORD, V. E., 1963. The ecology of North America, McGraw-Hill, New York, 644 pp. BRAUN, E. L., (1950) 1964, Deciduous forests of eastern North America, Hafner Publ. Co., New York, 596 pp., map. ECOLOGISTS' UNION and ECOLOGICAL SOCIETY OF AMERICA, 1950, "The biomes of North America", in The Living Wilderness, 15 (35), winter 1950-51. KUCHLER, A. W. 1964. Potential natural vegetation of the conterminons United States. Amer. Geog. Soc. Spec. Publ. 36. New York. Map and manual, 116 pp., illus.)

Following is one classification for the major communities to be expected in the Central Atlantic Region:

Deciduous Forest Formation
- Beech-Oak-Tuliptree (Mixed Mesophytic) Association
- Beech-Maple Association
- Oak-Chestnut Association
- Oak-Hickory Association
- Elm-Ash-Oak (mixed Hydrophytic) Association (edaphic, hydrophytic)

Southern Evergreen-Deciduous Forest Ecotones
- Oak-Pine Association
- Beech-Magnolia Association
- Cypress-Tupelo Association (edaphic, hydrophytic)

Northern Coniferous Forest Formation
- Spruce-Fir Association
- Pine-Hemlock Association
- Larch-Arbovitae Association (edaphic, hydrophytic)

Hardwood-Conifer Forest Ecotones
- Spruce-Maple Association
- Beech-Hemlock Association

Grassland Formation
- Fresh Marsh Association (edaphic)
- Brackish Marsh Association (edaphic)
- Salt Marsh Association (edaphic)
- Dune Grass Association (edaphic)

5. Present phase or stage

Identify the phase of succession by the life form of the dominants, as tree, shrub, perennial grass, perennial forb, or annual herb phase.

Identify the stage by the dominant species of the stand.

6. Apparent next stage

Estimate the probable next stage of succession from the kinds of plants establishing or reproducing themselves in the stand.

## C. LOCAL HABITAT

1. Site

Identify by an appropriate descriptive name for an identifiable homogeneous part of the landscape, as river terrace, sandy upland, etc. Forestry and other specialized fields have systematic nomenclatures for sites that are useful.

Underlying material. Identify kind of rock, as limestone, sandstone, etc.

Ecologic position. Describe the site in comparison with the normal or average of the region as indicated by the final stage of primary succession. Identify as:

Normal or average; effective microclimate producing the climatic climax (climax).
Better than normal or average; effective microclimate producing an edaphic climax of higher growth requirements than the climatic climax (postclimax).
Poorer than normal or average; effective microclimate producing an edaphic climax of lower growth requirements than the climatic climax (preclimax).

Topographic position. Describe landform and position, as floodplain, terrace, upper south slope, lower north slope, hilltop, etc.

2. Soil

Dig a hole or expose a fresh surface on the side of an excavation in a typical portion of the site and describe the soil. For a more detailed study, diagram the profile on the back of the worksheet.

Great Soil Group. Identify by Great Soil Group or other general category of soil classification (KELLOGG, C. E., 1956, The soils that support us, Macmillan, New York, 370 pp. BALDWIN, MARK, KELLOGG, C. E., and THORP, JAMES, 1938, "Soil classification" in USDA Yearbook, Soils and men, pp. 979-1001), or by Order in the newer "comprehensive" classification (BUCKMAN, HARRY O., and NYLE C. BRADY, 1969, The nature and properties of soils, 7th ed., Macmillan Co., New York, 653 pp.)

Series. Give the name of the specific kind of soil if known; consult local soil survey if available (U. S. Soil Conservation Service).

Texture. Describe the size of particles in the surface layer, or diagram for the entire profile:

Fine -- Clay; clays and clay loams. Moist soil is plastic; molds into ribbons; individual particles are too small to be seen or felt. Clay particles are less than 0.002 mm. in diameter.
Medium -- Silt; loams, silt loams, and sandy loams. Moist soil forms a stable ball, but ribbon breaks; particles floury, or a mixture of particles of different size. Silt particles are 0.002 to 0.05 mm. in diameter.
Coarse -- Sand; loamy sands. Cannot be molded; individual particles can be seen and felt. Sand particles are 0.5 to 2 mm. in diameter. Larger rock fragments are called gravel, stones, etc.

Depth. Measure to hard rock or other limitation to root growth, or to maximum extent of soil development.

Deep -- More than 36 in.
Moderately deep -- 20 to 36 in.
Shallow - 10 to 20 in.
Very shallow -- Less than 10 in.

Structure. Describe the general tilth, or arrangement of primary soil particles into secondary masses or aggregates, as:

Crumbly -- Soil loose and mellow; consisting of distinct "crumbs" or porous subangular pieces that separate from each other easily and retain their shape when handled or immersed in water.

Cloddy -- Soil dense and harsh; breaking into angular pieces of irregular shape and size that withstand handling but generally run together in water.

Massive -- Soil hard and without distinct natural cleavage into separate pieces.

Structureless -- Soil an unconsolidated mass of primary particles, as loose sand; single-grained.

The shape of the aggregates may be further indicated by descriptive terms, such as granular, nutlike, blocky, columnar, prismatic, etc.

Permeability. Describe the ease with which water (and, accordingly, air and plant roots) move through the most restrictive layer, or diagram all layers of the profile:

Slow -- Less than 0.8 in. per hr. Indicated by cleavage horizontal or none; structure cloddy or massive.

Medium -- 0.8 to 2.5 in. per hr. Indicated by cleavage slanting or vertical; structure crumbly or moderately cloddy.

Rapid -- More than 2.5 in. per hr. Cleavage in all directions or mainly vertical; structure weak crumbly, or single-grain.

In diagram of profile, show a distinct impervious layer or hardpan by solid shading.

Drainage. Describe the rate at which gravitational water leaves the soil after saturation:

Slow (poorly drained) -- Wet enough to impede or alter plant growth; root zone remains saturated more than 7 days after wetting. Indicated by gray layer or gray, yellow or brown mottling in topsoil (A horizon or upper 12 inches).

Medium (well drained) -- Drainage permitting normal root growth of most plants; root zone remains saturated 1 to 7 days after wetting. Indicated by gray or yellow and brown mottling in subsoil or parent material but not in topsoil (B or C horizon).

Rapid (excessive) -- Drainage too rapid for optimum plant growth; root zone remains saturated less than 24 hours after wetting. Indicated by absence of mottling in the solum and by shallow or very porous or rapidly permeable soils.

In diagram of profile, indicate water table by heavy wavy line across the profile.

Slope. Express slope of surface as percent (feet fall per 100 feet of horizontal distance), or describe as nearly level, gentle, moderate, steep, or very steep.

Erosion. Describe erosion or soil removal from the original profile as:

None or slight -- Less than 25% of surface soil removed.

Moderate -- 25% to 75% removed.

Severe -- More than 75% removed and occasional uncrossable gullies or occasional hummocks and blowouts.

Very severe -- With frequent uncrossable gullies or frequent hummocks and blowouts.

Organic matter. Describe evident organic matter content of soil, on basis of color and presence of decomposing organic materials, as high, medium, or low.

Life. Describe the apparent abundance of soil organisms (including decomposers) as abundant, common, or scarce.

Condition. Describe the general condition of the soil as compared to the original undisturbed soil, as a favorable environment for plant growth, as improved, natural, good, fair, or poor.

(U.S.D.A. Agr. Hbk. 18, Soil survey manual, 503 pp. U.S.D.A. Yearbook, 1938, Soils and men, 1,232 pp., and 1957, Soil, 784 pp. STALLINGS, J. H., 1957, Soil conservation, Prentice-Hall, Englewood Cliffs, N. J., 575 pp.)

3. Land use

Record the use being made of the land, as cropland, woodland, pasture, wildlife, recreation, residential, or other.

Land capability. Determine capability class in the standard classification used by soil conservationists (consult soil survey of area, if available) and decide if present use is safely within the limits of the site.

Classes I, II, and III are suitable for continuous cultivation with no (I) simple (II), or complex and intensive (III) conservation treatments.

Class IV is suitable for only limited or occasional cultivation with complex and intensive conservation treatments.

Classes V, VI, and VII are not suitable for cultivation but need to be in permanent vegetation (pasture, woodland, wildlife, or recreation) with no (V), moderate (VI) or severe (VII) restrictions in use.

Class VIII is not suitable for any use that disturbs soil or cover. (KLINGABIEL, A. A. and MONTGOMERY, P. H., 1961. Land-capability classification, U.S.D.A. Agr. Hbk. 210, 21 pp. STALLINGS, J. H., 1957 Soil conservation, Prentice-Hall Englewood Cliffs, N. J., 575 pp.)

Condition. Describe the present condition of the site and its cover for the purposes of the current use, as excellent, good, fair, or poor. Special standards are used for evaluating forests, range, etc.

Conservation effectiveness. Make a judgment as to whether the basic resources are improving, being maintained, or deteriorating under current use and management. Accordingly, indicate conservation effectiveness as superior, adequate, or inadequate

## D. NOTES AND WORKSHEETS

The worksheets that follow are for convenience in organizing and interpreting your observations in terms of an ecological system. The items follow the sequence of the descriptive paragraphs and references in the preceding section.

Worksheet No. 1. "Description of Physical Environment". This worksheet is useful as a guide to observations in the field. The information in Section A, "General Environment", is best filled in from source materials before going to the field. Section B, "Local Habitat", can be filled in from direct observation. The diagram of the soil profile, on the back, with descriptive notes beside it, should be prepared on the spot.

Worksheet No. 2. "Composition and Structure of Biotic Community". Notes on animals observed (Section B, "Consumers") are best made on plain paper or cards in the field, for the observations will not follow any preordained sequence. Moreover, you likely will not know the ecological role of several of the observed species until you consult references on food habits and life history. After the facts are assembled at home, the entries can be grouped according to the headings on the worksheet and further within each column according to the source of food. The resulting array of species names presents in tabular form an elementary food web of the community.

Much of the information you gather about animal populations on the area will be no more than inference from "sign" or evidence observed: tracks, burrows, old nests, tooth marks, feces, and the like. It is important to distinguish in your notes between such hard facts and the resulting inferences and speculation. Let your basic record indicate tracks, burrows, old nests, etc.: be no more specific as to kind than your knowledge at the time (e.g., "mice" or "deermouse?" rather than "whitefooted deermouse"). You will find one piece of evidence supporting another so that you can come to rather firm conclusions on many points; but, unless you devote unending time to the study of an area, you must live with continuing questions. What better incentive to keep you interested in a rewarding outdoor activity?

Principal plant species can be entered directly in Section A, "Producers", or on a plain sheet similarly divided into blocks. Add the abundance ratings after the appraisal is complete, and indicate the species judged to be dominant and subdominant.

Worksheet No. 2A (See page 16). "Description of Biotic Community." This short form can be used in lieu of Worksheets No. 1 and 2 to describe additional nearby sample areas on what is considered the same kind of site as one already completely described.

Worksheet No. 3. "Summary of Animals Observed." This worksheet provides for a cumulative record of animals observed on successive trips, either to the same or different areas. Each species is listed only once and the succeeding abundance observations are entered in the columns opposite, making it possible to compare findings at different places or times.

Worksheet No. 4. "Potential Density and Biomass." This worksheet is intended to provide an understanding of the general trophic structure of biotic communities and for comparing different communities. Data on normal maximum density for the different species admittedly are fragmentary and difficult to find, hence provision is made for recording the source of each figure used. A complete calculation for every species in a community is out of the question for casual study but if you use the 2, 3, or 4 most frequent and most abundant species of each trophic level, the mathematical result will be a fair representation of the biotic structure of the vertebrate component of the community. Similar analyses of different communities will highlight significant differences in species composition and indicate ecological equivalents.

You can apply the resulting figures in a general way to a specific community you have inventoried by adjusting the potential biomass of each species by a percentage corresponding to its estimated abundance in your example.

Worksheet No. 1

# DESCRIPTION OF PHYSICAL ENVIRONMENT of an ecosystem

Location _____ Date _____

Association _____ Area No. _____
(From Worksheet No. 2)

## GENERAL ENVIRONMENT

1. Climate _____

   Rainfall _____ Temperature _____ Growing season _____

   Moisture index _____ Temp. index _____

2. Physiographic area _____

3. Regional (climatic) climax _____

## LOCAL HABITAT

1. Site (descriptive name) _____

   Underlying material _____

   Topographic position _____

   Ecologic potential _____

2. Soil: Great soil group _____

   Series _____ Texture _____

   Depth _____ Structure _____

   Permeability _____ Drainage _____

   Slope _____ Erosion _____

   Organic matter _____ Life (organisms) _____

   Condition _____

   (For more detail, complete Soil Profile Description on back of sheet)

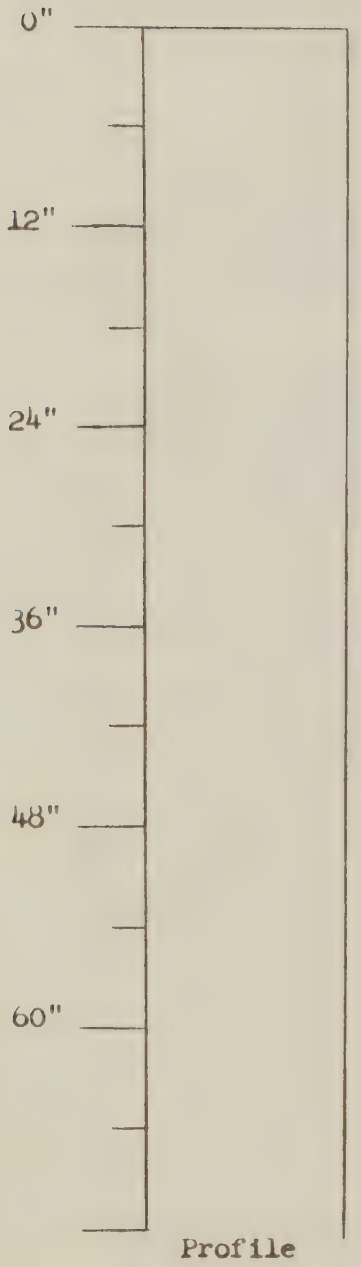
3. Land use: _____

   Capability class _____ Condition _____

   Conservation effectiveness _____

SOIL PROFILE DESCRIPTION

Horizon (layer) — Description (Structure, color, etc.)




Profile

LEGEND

| Texture | Permeability | Special features |
|---|---|---|
| Fine (clay) | Slow | Impervious layer (hardpan) |
| Medium (silt or loam) | Medium | Poorly drained (slow) |
| Coarse (sand) | Rapid | Water table |

Worksheet No. 2

COMPOSITION AND STRUCTURE OF BIOTIC COMMUNITY

Location _____ Date _____

Association or type _____ Area No. _____

Successional phase or stage _____

Apparent next stage _____

PRODUCERS (Green plants)

| Trees | Abundance | Shrubs and vines | Abundance | Herbs | Abundance |
|---|---|---|---|---|---|
| Canopy: | | Shrubs: | | Grasses: | |
| Understory: | | Vines: | | Forbs (including ferns): | |

SAPROPHYTES AND DECOMPOSERS:

MOSSES AND LICHENS:

Indicate: Dominants--D, d; Subdominants--S, s (capital letter for canopy layer, small letter for subordinate layer).

CONSUMERS (Animals)

| Herbivores | Abundance | Primary predators | Abundance | Secondary and top predators | Abundance |
|---|---|---|---|---|---|
| Saprovores | | Parasites | | Scavengers and Others | |

Worksheet No. 3
SUMMARY OF ANIMALS OBSERVED

| Species | Role | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
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(See explanation on back. Rule additional sheets if needed.)

## Explanation

Role. Show predominant role of each species in the communities observed:

Primary consumers

H Herbivores. Animals that feed directly on plants and their fruits.

| | | | |
|---|---|---|---|
| Hb | Bark eaters | Hr | Root eaters |
| Hf | Fruit eaters | Hs | Seed and nut eaters |
| Hl | Leaf eaters | Ht | Twig and bud eaters |
| Hj | Juice eaters | Hw | Wood eaters |

$S_1$ Saprovores. Animals that feed on dead and decaying plant materials or indiscriminately on plant and animal remains.

Secondary consumers

P Predators or carnivores. Animals that feed on other animals that they kill.

$P_1$ Primary predators. Feed mainly on herbivores.

$P_2$ Secondary or top predators. Feed on other predators or large herbivores.

$P_p$ Parasites. Animals that feed on live animals without killing.

O Omnivores. Animals that feed on plant and animals in about equal proportions.

$S_2$ Scavengers. Animals that feed mainly on carrion and excreta.

Abundance. In the absence of census data, show relative abundance by classes based on frequency of occurrence of evidence of presence at several observation points or sample areas.

S Scarce. An isolated observation, or less than 10% frequency; not ecologically important.

O Occasional. A few observation, 10-35% frequency; slightly important.

C Common. Several observations, 35-65% frequency; moderately important.

A Abundant. Numerous observations, 65-90% frequency; of major importance.

VA Very abundant. Generally prevalent, 90-100% frequency; practically monopolizing its ecological role in the community.

Identification of observation stations (columns on front of page):

| No. | Association and phase | Place and date of observation |
|---|---|---|
| 1. | _____ | _____ |
| 2. | _____ | _____ |
| 3. | _____ | _____ |
| 4. | _____ | _____ |
| 5. | _____ | _____ |
| 6. | _____ | _____ |
| 7. | _____ | _____ |
| 8. | _____ | _____ |
| 9. | _____ | _____ |
| 10. | _____ | _____ |

Worksheet No. 4

POTENTIAL DENSITY AND BIOMASS
of principal vertebrates

Biome or association _____

| Species | Density (source) | Weight | Biomass |
|---|---|---|---|
| | No. | Lb. | Lb. |
| Secondary or top predators: | | | |
| _____ | ( ) | | |
| _____ | ( ) | | |
| Total | | | |
| Primary predators: | | | |
| _____ | ( ) | | |
| _____ | ( ) | | |
| _____ | ( ) | | |
| Total | | | |
| Herbivores: | | | |
| _____ | ( ) | | |
| _____ | ( ) | | |
| _____ | ( ) | | |
| _____ | ( ) | | |
| Total | | | |

Explanation:
Density. Normal maximum number per 100 acres (Source): Use letters in parentheses to indicate source of information; list references with letter key on back of page.
Weight. Average or median weight of adult.
Biomass. Density times weight (col. 1 x col. 2).

List the vertebrate species most commonly found in greatest abundance in several examples of the same biome, association, or other category of biotic community.

Worksheet No. 2A

DESCRIPTION OF BIOTIC COMMUNITY
(Short form)

Location _____ Area No. _____

Site _____ Date _____

Description (same as Area No. _____ except:)

BIOTA

Association or type _____

Successional phase _____

Dominants _____

Subdominants _____

Apparent next stage _____

| PRODUCERS (green plants) | Abundance | CONSUMERS (animals) | Abundance |
|---|---|---|---|
| | | | |

# II. CLASSIFICATION OF TERRESTRIAL ECOSYSTEMS

## Major Categories

FORMATION (Biome). The largest division of terrestrial ecosystems or communities, characterized by uniformity of life form of the climax dominants, which on land are always plants. Since the life form of vegetation reflects major features of climate and determines the nature of habitat of animals, it provides a sound basis for natural ecological classification. E.g., Deciduous Forest, Coniferous Forest, Grassland.

ASSOCIATION. Regional subdivisions of the formation, naturally determined by the subclimates within each general climate, and characterized by the regular association of certain genera of plants as climax dominants and the consistent occurrence of characteristic animals. E.g., Oak-Hickory Forest, Beech-Maple Forest, True Prairie.

TYPE. Within the association, groupings of specific units (see below) characterized by certain combinations of species (one or more) as climax dominants over significant areas and by essentially similar sequences of secondary succession (subseres). E.g., White Oak Forest, Red Oak-Mockernut Hickory Forest, Little Bluestem Prairie.

UNIT (Biotope). Local and concrete ecosystems or communities where environmental conditions resulting from variations in soils, topography, and other features in combination with climate produce a climax biotic community unique in species composition and productivity. The Unit includes, as well as the climax community, all the successional stages or conditions that may exist on a site having a uniform potential for the climax. It is the practical "management" unit of classification, which must be defined in each case to recognize whatever degree of difference in either kind (composition) or quantity (productivity) is significant for the purposes of the classification. E.g., range sites for range management, forest sites for forestry, habitat units for game management, etc.

## Terminology

The general terms, "formation," "association," "type," and "unit," may be appropriately modified to indicate the scope of the classification--

1. By "biotic" if both plants and animals are considered or meant;
2. By "plant" or "vegetation" if only plants are considered or meant.

There are no corresponding recognized categories of animal communities considered separately from plants.

The terms "biome" and "biotope" in the strict sense refer only to the biotic community but are commonly used to mean the total ecosystem.

## Units of the Classification

| Scope of classification | Categories: FORMATION | ASSOCIATION | TYPE | UNIT |
|---|---|---|---|---|
| BIOTIC COMMUNITY | Biotic formation (Biome) | Biotic association | Biotic type | Biotic unit (Biotope) |
| PLANT COMMUNITY | Plant formation | Plant association | Vegetation type | Vegetation unit |
| PHYSICAL ENVIRONMENT | Climatic province | Climatic region | Edaphic type | Site |

The units within each category of community are named by the principal climax (or climax and subclimax) dominants that characterize them; e.g., Deciduous Forest Formation (life form); Beech-Maple Association, Oak-Tuliptree Association (genera); Red Oak-Mockernut Hickory Type (species); White Oak Upland Biotope (combination of species and site).

## Successional Units

Each biotic unit or type includes all the developmental communities in the succession (sere) leading to the climax. Developmental communities may be identified and described as stages or phases according to the following definitions:

STAGE. A community characterized by a single dominant, or by two or more codominants that gain and lose control simultaneously.

PHASE. A sequence of stages of the same life form.

The normal sequence of life forms (phases) is:

1. Annual herbs (forbs and grasses)
2. Perennial forbs
3. Perennial grasses
4. Shrubs (usually called "scrub" if climax)
5. Trees.

The position of stages or phases in the successional sequence can be characterized as:

1. Pioneer. The initial and early developmental stages of other than the climax life form.
   a. Annual weeds (forbs and grasses).
   b. Perennial forbs.
   c. Perennial grasses (in forest).
   d. Shrubs (in forest).
2. Transitional. Middle stages dominated by plants of the climax life form that are absent or unimportant in the climax.
3. Subclimax. The stage just before the climax, dominated by plants of the climax life form and ordinarily by species that occur as subdominants or incidentals in the climax.
4. Climax. The final stabilized community (one stage). Stability is judged in terms of human experience, not geologic time. A community is recognized to be in the climax stage if dominated by the species considered climax for the site, whatever the variations in composition or associated species.

## Some Related Definitions

### Ecosystems and communities

ECOSYSTEM. The living organisms and nonliving environment of any (homogeneous) area, or any site, operating together as a functional entity.

COMMUNITY. An aggregation of interdependent organisms (either plants or animals or both) with mutual relations to the same environment; applied to any unit without regard to its rank in classification or its permanence.

SITE. A unit of land that produces a particular kind of biotic community which, in the climax stage, is uniform in composition and productivity. Site connotes "location" or "place" and includes all the physical (nonliving) features of the environment.

VEGETATION. The plant life (plants) of an area considered collectively; the flora.

WILDLIFE. The animal life (animals) of an area considered collectively; the fauna.

BIOTA. The plant and animal life (vegetation and wildlife) of an area considered collectively; the flora and fauna.

BIOTIC. The adjective form of biota; pertaining to or considering both plant and animal life.

DOMINANT(S). The organism or organisms that largely control the energy flow of the ecosystem and exert the greatest influence on the environment in which the other organisms of the community live; generally the largest and most abundant ones. As an arbitraty guide to mathematical determination of dominant plants on the land, the smallest number of the most abundant species of the canopy which, taken together, comprise more than 50 percent of the cover are considered dominants.

SUBDOMINANT(S). The subordinate organisms which yet are important in their influence on the energy flow of the ecosystem and on the environment in which the other species of the community live. As an arbitrary guide to mathematical determination of subdominants on land, those species that are not dominant but which individually comprise 10 percent or more of the cover of the canopy, or those that would be considered dominants of an understory, are considered subdominants of the total community.

### Succession

SUCCESSION. The orderly replacement of one community by another on a given site. Retrogression is the reverse of succession.

Primary succession. The original or undisturbed development of the climax community on a site.

Secondary succession. The succession that occurs after the original community on a site is removed or disturbed. Secondary succession always proceeds toward restoration of the climax community.

SERE. The series (sequence) of communities (stages) that comprise the succession on a site. Subsere is the sequence of secondary succession.

## Climax

CLIMAX. The final stabilized community on a site; i.e., one in which there is no appreciable natural change in a period significant in human affairs.

Climatic climax. A climax community that is controlled by conditions of the general climate of the region; i.e., one on a site that is neither more nor less favorable for growth than the average of the climatic region.

Edaphic climax. A climax community that is limited or made possible by special conditions in the site that make it either more or less favorable for growth than the average climate of the region.

SUBCLIMAX. The community (or stage in succession) just before the climax for a site.

PRECLIMAX. A stabilized (edaphic climax) community below the climatic climax in primary succession; i.e., an edaphic climax on a site less favorable for growth than that required by the climatic climax. A preclimax site is one that supports a preclimax community.

POSTCLIMAX. A stabilized (edaphic climax) community beyond the climatic climax in primary succession; i.e., an edaphic climax on a site more favorable for growth than that required by the climatic climax. A postclimax site is one that supports a postclimax community.

## Some Ecological Principles Used in Classifying Ecosystems

1. The ecosystem is the fundamental ecological unit of nature. The whole ecosystem, rather than some part of it, is the thing to be classified.

2. The climax community is the stable basis for comparing biotas and ecosystems. It is the measure of the productive potential of the environment. The classification, therefore, is based primarily on the properties of climax communities.

3. Where biotic communities are the same the effective environments of their sites are the same. Conversely, were all physical factors of the environment are the same, the potential biotic communities are the same. Hence, the fundamental ecological units, or ecosystems, can be identified either by their biotas or by the combinations of physical factors that make up their environments.

4. A few dominant species in each biotic community control or greatly influence the environment of all the others, hence significantly different communities can be recognized by their dominants. The climax dominants of major communities on land are plants, although animals may sometimes dominate temporary or minor local communities. Variations in subdominants are regarded as variations of major communities.

5. The stages of secondary succession measure changes or variations of the same community in time. They are, therefore, but successive phases of the same biota or ecosystem of a given site. As such, they provide a scale for recognizing the "condition" of an ecosystem in terms of the deviation of its biota from its potential or climax.

## III. COMPOSITION AND STRUCTURE OF MAJOR FOREST COMMUNITIES

Since biotic communities and their ecosystems are identified by their dominant (plant) species, composition lists of the major communities likely to occur in the region of interest are a necessary requirement for field identification. For the student of communities, they serve the function of the familiar "field guides" for identification of species of birds, wildflowers, and the like.

The following lists are drawn from a combination of published sources and field observations in the Central Atlantic Region and throughout the eastern United States.

To use these lists as an identification guide, first complete the front page of the worksheet, "Composition and Structure of Biotic Community" as described in Chapter I. Then compare the dominants of the existing community on your study area with the lists. If the present dominants are predominantly of species listed as climax dominants or subdominants for one of the associations, you may confidently consider your sample stand as a biotope of that association.

If the dominants of your sample stand are of developmental stages, then you must look for clues among the subordinate species which are potential climax dominants. By weighing the relative abundance of representatives of the different associations, and noting the developmental dominants that may be characteristic of certain associations, you can usually arrive at a tentative conclusion as to the local or edaphic climax.

Having decided to what association your sample belongs, you identify the phase and stage by the life form and species of the present dominants.

You can judge the apparent next stage by the young plants in the understory that are listed as potential dominants in the same or a higher developmental stage of that association.

## A. THE DECIDUOUS FOREST BIOME

The climax and most developmental stages are dominated by deciduous broadleaf trees and shrubs. The following associations occur in the Central Atlantic Region and adjacent areas:

Climax associations, that occupy normal sites in their climatic regions and drier or wetter than normal sites of equivalent microclimates in other regions:

Beech-Oak-Tuliptree (Mixed Mesophytic) Association
Beech-Maple Association
Oak-Chestnut Association
Oak-Hickory Association

Edaphic (hydric) association, that occupies wetter than normal sites in all climatic regions:

Elm-Ash-Oak (Mixed Hydrophytic) Association

Plant composition lists follow.

Animals. For lists of the principal vertebrate animals, see Animal Ecology (S. Charles Kendeigh, 1961), pp. 295-298. His list for the "North American deciduous forest biociation" generally applies to the climax condition of the biome; "North American deciduous forest-edge biociation" to developmental stages and to ecotones with the Grassland Biome. Also see sections in the discussion of the biome in general and the various associations in Ecology of North America (Shelford 1963), ch. 2 (pp. 17-55), ch. 3 (pp. 56-62) and ch. 4 (pp. 89-118).

# 1. BEECH-OAK-TULIPTREE (MIXED MESOPHYTIC) ASSOCIATION

## Climax and Subclimax Phases

### 1. Climax trees

Usual dominants:
American beech, Fagus grandifolia
Sugar maple, Acre saccharum
Canada hemlock, Tsuga canadensis
Red oak, Quercus rubra (borealis var. maxima)

Principal codominants and subdominants:
*Yellow buckeye, Aesculus octandra
*White basswood, Tilia heterophylla
*Cucumber magnolia, Magnolia acuminata
White ash, Franxinus americana
Black walnut, Juglans nigra
Shagbark hickory, Carya ovata
Bitternut hickory, C. cordiformis
Also subclimax dominant species and various species from other associations

### 2. Subclimax trees

Characteristic dominants:
**Tuliptree (yellow poplar) Liriodendron tulipifera
Yellow birch, Betula lutea (alleghaniensis)

Principal associates:
Black cherry, Prunus serotina
Red maple, Acer rubrum
Black tupelo (gum), Nyssa sylvatica
Also species from other associations

### Small trees and shrubs

**Common pawpaw, Asimina triloba
*Umbrella magnolia, M. tripetala
*Sourwood, Oxydendron arboreum
Striped maple, Acer pensylvanicum
Shadblow serviceberry, Amelanchier arborea
American hornbeam (Ironwood, bluebeech), Carpinus caroliniana
Smooth hydrangea, Hydrangea arborescens
Rosebay rhododendron, Rhododendron maximum

**Dominants or subdominants characteristic of the association.
*Characteristic of the association but usually scarce in our region.

Beech-Oak-Tuliptree Association

Herbs

Seedplants:
Cohosh bugbane, Cimicifuga racemosa
Blue Cohosh, Caulophyllum thalictroides
Pale snapweed (touch-me-not), Impatiens pallida
Canada woodnettle, Laportea canadensis
Snow trillium, Trillium grandiflorum
Purple trillium, T. erectum
Common fawnlily (adders-tongue), Erythronium americanum
Large yellow lady's-slipper, Cypripedium calceolus var. pubescens
Canada bloodroot, Sanguinaria canadensis
Violets, Viola spp.
Rue-anemone, Anemonella thalictroides

Ferns:
Toothed woodfern, Dryopteris spinulosum
Silvery spleenwort, Athyrium thelypteroides
Beech woodfern (beechfern), Dryopteris hexagonoptera
American maidenfern, Adiantum pedatum
Narrowleaf spleenwort, Athyrium pycnocarpon
Interrupted floweringfern, Osmunda claytoniana

Developmental Phases

3. Transitional phase: Shrubs and small trees

Black locust, Robinia pseudoacacia
Sassafras, Sassafras albidum
Persimmon, Diospoyros virginiana
Hawthorn, Crataegus spp.
Smooth sumac, Rhus glabra
Poisonivy, Rhus toxicodendron
Dewberry, blackberry, etc., Rubus spp.
Greenbriar, Smilax spp.
(Also shrub species from the subclimax understory and from other associations)

4. Perennial weed phase: Herbs (forbs and grasses)

Bluestems, Andropogon spp.
Indiangrass, Sorghastrum nutans
Uniola, Uniola spp.
Heartleaf aster, Aster cordifolius
Branching (wood) aster, Aster divaricatus
Wreath goldenrod, Solidago caesi
Zigzag goldenrod, S. flexicaulis
White snakeroot, Eupatorium rugosum
Cinquefoil, Potentilla spp.
Cutleaf coneflower, Rudbeckia laciniata
Oswego beebalm, Monarda didyma

5. Annual weed phase: Herbs (forbs and grasses)

Looseflowered scorpionweed, Phacelia bipinnatifida
Giant ragweed, Ambrosia trifida
Fleabane, Erigeron sp.
Nimblewill muhly, Muhlenbergia schreberi
Also species from other associations

- - - - -

## 2. BEECH-MAPLE ASSOCIATION

### Climax and Subclimax Phases

#### 1. Climax trees

| Usual dominants | Principal codominants and subdominants |
|---|---|
| American beech, Fagus grandiflora | White oak, Quercus alba |
| Sugar maple, Acer saccharum | Red oak, Q. rubra |
| [1]American basswood, Tilia americana | American (white) ash, Fraxinus americana |
| | [1]Smooth (Ohio) buckeye, Aesculus glabra |
| | [1]Shagbark hickory, Carya ovata |
| | [1]Black walnut, Juglans nigra |
| | [1]Butternut walnut, Juglans cinerea |

#### 2. Subclimax trees

Red maple, Acer rubrum
[1]American elm, Ulmus americana
[1]Slippery elm, U. fulva
[2]Striped maple, A. pensylvanicum
[2]Yellow birch, Betula lutea

##### Small trees and shrubs

American hornbeam (ironwood), Carpinus caroliniana
American hophornbeam, Ostrya virginiana
Flowering dogwood, Cornus florida
Common witchhazel, Hamamelis virginiana
Fly honeysuckle, Lonicera canadensis
Northern bushhoneysuckle, Diervilla lonicera
Hobblebush viburnum, Virburnum alnifolium
Running euonymous, Euonymous obovatus
Northern pricklyash, Xanthoxylum americanum

##### Herbs

Canada beadruby, Maianthemum canadensis
Yellow beadlily, Clintonia borealis
Claspleaf twistedstalk, Streptopus amplexifolius
Roundleaf fringed-orchis, Habenaria orbiculatus
Naked (Sarsaparilla) aralia, Aralia nudicaulis
Northern bedstraw, Galium boreale
Canada (squirrelcorn) bleedingheart, Dicentra canadensis
Creeping partridgeberry, Mitchella repens
American starflower, Trientalis borealis
Trillium, Trillium spp.
Violet, Viola spp.
Cranesbill, Geranium spp.

---

[1]Lake States (Beech-Maple) Faciation
[2]Mountain (Maple-Birch) Faciation

## Developmental Phases

### 3. Transitional Phase: Shrubs and small trees

Quaking aspen, Populus tremuloides
Bigtooth aspen, P. grandidentata
Black cherry, Prunus serotina
Pin cherry, P. pensylvanica
[1]Hawthorn, Crataegus spp.
[2]Paper birch, Betula papyrifera
[3]Gray birch, B. populifolia
American mountainash, Pyrus (Sorbus) americana
Mountain holly (winterberry), Ilex montana
Beaked hazelnut, Corylus vernuta
Scarlet elder, Sambucus pubens
Small raspberry (thimbleberry, salmonberry), Rubus parviflorus
Red raspberry, R. idaeus
Pagoda dogwood, Cornus alternifolia
Stiff dogwood, C. foemina
Roughleaf dogwood, C. rugosa
Sumac, Rhus spp., esp. staghorn sumac, R. typhina
Poisonivy, Rhus toxicodendron
Sweetfern, Comptonia peregrina

### 4. Perennial weed phase

Grasses:
Tall oatgrass, Arrhenatherum elatius
Kentucky bluegrass, Poa pratensis
Canada bluegrass, P. canadensis
Common timothy, Phleum pratense
Panicgrass, Panicum spp.
Spiked povertygrass (Poverty oatgrass) Danthonia spicata

Forbs:
Goldenrod, Solidago spp.
Aster, Aster spp.
Thoroughwort, Eupatorium spp.
Ironweed, Vernoñia spp.
Harvestlice (Agrimony), Agrimonia spp.
Slender lopseed, Phyrma leptostachya
Cinquefoil, Potentilla spp.

Ferns:
Toothed woodfern, Dryopteris spinulosa
Hayscented cupfern, Dennstaedtia punctilobula
Common bracken, Pteridium aquilinum

### 5. Annual weed phase

Crabgrass, Digitaria sanguinalis
Threeawn, Aristida spp.
Bristlegrass, Setaria spp.
Wild carrot, Daucus carota
Lettuce, Lactuca spp.

## 3. OAK-CHESTNUT ASSOCIATION

### Climax and Subclimax Phases

#### 1. Climax trees

| Usual dominants: | Principal codominants and subdominants: |
|---|---|
| *American chestnut, Castanea dentata (formerly) | White oak, Q. alba |
| *Chestnut oak, Quercus prinus (montana) | Scarlet oak, Q. coccinea |
| Red oak, Q. rubra (borealis var. maxima) | Southern red oak, Q. falcata |
| | Shagbark hickory, C. ovata |
| | Pignut hickory, C. glabra |
| | Also subclimax dominant species |

#### 2. Subclimax trees

| Usual dominants: | Principal associates: |
|---|---|
| Red maple, Acer rubrum | American hophornbeam, Ostrya virginiana |
| Black tupelo (gum), Nyssa sylvatica | Also species from the Oak-Hickory association |
| Sweet (black) birch, Betula lenta | |

#### Small trees and shrubs

| Deciduous: | Heath: |
|---|---|
| Flowering dogwood, Cornus florida | *Mountain laurel, Kalmai latifolia |
| Common witchhazel, Hamamelis virginiana | *Blueberry, etc., Vaccinium spp. |
| Common mountain-camelia, Stewartia ovata | *Huckleberry, Gaylussacia spp. |
| Allegheny oilnut, Pyrularia pubera | Flame azalea, Rhododendron calendulaceum |
| Cinnamon whitealder, Clethera acuminata | He-huckleberry, Lyonia ligustrina |
| Mapleleaf viburnum, Viburnum acerifolium | Fetterbush, Leucothoe sp. |

#### Herbs

| | |
|---|---|
| Threeleaf rattlesnakeroot, Prenanthes trifoliata | Southern bellflower, Campanula divaricata |
| Barestem tickclover, Desmodium nudiflorum | Trailing arbutus, Epigaea repens |
| Downy rattlesnakeplantain, Goodyeara pubescens | Checkerberry wintergreen, Gaultheria procumbens |
| Leafless wandflower, Galax aphylla | |

* Dominants or subdominants characteristic of the association.

Oak-Chestnut Association

Developmental Phases

3. Transitional phase: Shrubs and small trees

Black locust, Robinia pseudoacacia
Sassafras, Sassafras albidum
Persimmon, Diospyros virginiana
Hawthorn, Crataegus spp.
Eastern redcedar, Juniperus virginiana
Smooth sumac, Rhus glabra
Staghorn sumac, Rhus typhina
American elder, Sambucus canadensis
Common greenbriar, Smilax rotundifolia
Virginia creeper, Parthenocissus quinquifolia
Grape, Vitis spp.

4. Perennial weed phase: Herbs (forbs and grasses)

Virginia bluestem (broomsedge), Andropogon virginicus
Other bluestems, Andropogon spp.
Purpletop, Tridens flava
Aster, Aster spp.
Goldenrod, Solidago spp.
Bushclover, Lespedeza spp.
Tickclover, Desmodium spp.

5. Annual weed phase: Herbs (forbs and grasses)

Ragweed, Ambrosia spp.
Fleabane, Erigeron spp.
Bushclover, Lespedeza annual spp.
Tickclover, Desmodium annual spp.
Annual grasses

## 4. OAK-HICKORY ASSOCIATION

### Climax and Subclimax Phases

#### 1. Climax trees

| Usual dominants: | Principal codominants and subdominants: |
|---|---|
| Red oak, Q. rubra (borealis var maxima) | Post oak, Q. stellata |
| White oak, Quercus alba | Shumard oak, Q. shumardii |
| Black oak, Q. velutina | Blackjack oak, Q. marilandica |
| Scarlet oak, Q. coccinea | Shagbark hickory, Carya ovata |
| Southern Red oak, Q. falcata | Pignut hickory, C. glabra |
| | Bitternut hickory, C. cordiformis |
| | Mockernut hickory, C. tomentosa |

#### 2. Subclimax trees

| | |
|---|---|
| Sweetgum, Liquidambar styraciflua | Winged elm, Ulmus alata |
| Hackberry, Celtis sp. | American hornbeam, Carpinus caroliniana |

#### Shrubs and small trees

| | |
|---|---|
| Flowering dogwood, Cornus florida | Jerseytea buckbrush, Ceanothus americanus |
| Redbud, Cercis canadensis | Serviceberry, Amelanchier sp. |

### Developmental phases

#### 3. Transitional phase: Shrubs and small trees

| | |
|---|---|
| Black locust, Robinia pseudoacacia | Smooth sumac, Rhus glabra |
| Sassafras, Sassafras albidum | Poison ivy, Rhus toxicodendron |
| Persimmon, Diospyros virginiana | Dewberry, blackberry, Rubus |
| Hawthorn, Crataegus | Virginia pine, Pinus virginiana, (in some areas) |
| Eastern redcedar, Juniperus virginiana | |

#### 4. Perennial weed phase: Herbs (forbs and grasses)

| | |
|---|---|
| Virginia bluestem (broomsedge), Andropogon virginicus | Purpletop, Tridens flava |
| | Aster, Aster spp. |
| Other bluestems, Andropogon spp. | Goldenrod, Solidago spp. |

#### 5. Annual weed phase: Herbs (forbs and grasses)

| | |
|---|---|
| Ragweed, Ambrosia spp. | Camphorweed, Heterotheca spp. |
| Fleabane, Erigeron spp. | Crabgrass, Digitaria sanguinalis |
| | Green bristlegrass, Setaria viridis |

## 5. ELM-ASH-OAK (MIXED HYDROPHYTIC) ASSOCIATION

### Climax and Subclimax Phases

#### 1. Climax trees

| Characteristic dominants: | Principal subdominants and associates: |
|---|---|
| *Water oak, Quercus nigra | Pin oak, Q. palustris |
| *Overcup oak, Q. lyrata | White oak, Q. alba |
| *Willow oak, Q. phellos | Shellbark hickory, Carya laciniosa |
| *Basket (swamp chestnut) oak, Q. michauxii | Black ash, F. nigra |
| Green ash, Fraxinus pennsylvanica | *Pumpkin ash, F. profunda |
| White ash, F. americana | *Red mulberry, Morus rubra |
| *Silver maple, Acer saccharinum | *Kentucky coffeetree, Gymnocladus dioica |
| Red maple, A. rubrum | *Common honeylocust, Gleditsia triacanthos |
| *Swamp black tupelo, Nyssa sylvatica var. biflora | *Sycamore, Platanus occidentalis |
| *American elm, Ulmus americana | Other oaks and hickories |
| *Slippery elm, U. fulva | Also subclimax dominant species |

#### 2. Subclimax trees

| Characteristic dominants: | Principal subdominants and associates: |
|---|---|
| Sugar hackberry, Celtis laevigata | *Swamp cottonwood, Populus heterophylla |
| Common hackberry, C. occidentalis | Bigtooth aspen, Populus grandidentata |
| Sweet gum, Liquidambar styraciflua | |
| *River birch, Betula nigra | |
| *Boxelder, Acer negundo | |

#### Small trees and shrubs

| | |
|---|---|
| American hornbeam, Carpinus caroliniana | Roughleaf dogwood, Cornus drummondi |
| Common pawpaw, Asimina triloba | Summersweet whitealder, Clethera alnifolia |
| Sweetbay magnolia, Magnolia virginiana | Swamp azalea, Rhododendron viscosum |
| Winterberry holly, Ilex verticillata | Sweetbells fetterbush, Leucothoe racemosa |
| Arrowwood virburnum, Virburnum dentatum | He-huckleberry, Lyonia ligustrina |
| Possumhaw virburnum, V. nudum | Common spicebush, Lindera benzoin |
| Alabama supplejack, Berchemia scandens | American bittersweet, Celastrus scandens |

#### Herbs

| Forbs: | Grasses and sedges: |
|---|---|
| Common elephantsfoot, Elephantopus carolinianus | Stout woodreed, Cinna arundinacea |
| Spotted snapweed, (touch-me-not), Impatiens (biflora) capensis | Straight sedge, Carex stricta |
| Canada waterleaf, Hydrophyllum canadense | Folliculate sedge, C. folliculata |
| Limestone ruellia, Ruellia strepens | |
| **Ferns:** | |
| Marsh woodfern (marshfern), Dryopteris thelypteris | Netvein chainfern, Woodwardia areolata |
| Cinnamonfern, Osmunda cinnamomea | Spleenwort ladyfern, Athyrium filix-femina var. asplenoides |

*Dominants or subdominants characteristic of the association.

Elm-Ash-Oak Association

Developmental Phases

3. Transitional phase: Shrubs and small trees

*Eastern cottonwood, Populus deltoides
*Black willow, Salix nigra
*Sandbar willow, S. interior
*Common alder, Alnus serrulata
*Common buttonbush, Cephalanthus occidentalis
American elder, Sambucus canadensis
Swamp rose, Rosa palustris
Hawthorn, Crataegus spp.
Dewberries, Rubus spp.
Poisonivy, Rhus toxicodendron
Cat greenbriar, Smilax glauca
Grape, Vitis spp.
Common trumpetcreeper, Campsis radicans
Common peppervine, Ampelopsis arborea

4. Perennial weed phase: Herbs (Forbs and grasses)

Grasses, sedges, and rushes:
Eastern gamagrass, Tripsacum dactyloides
Indiangrass, Sorghastrum nutans
Rice cutgrass, Leersia oryzoides
Uniola, Uniola sp.
Wildrye, Elymus spp.
Switchgrass, Panicum virgatum
Longleaf panicgrass, P. longifolium
Broom sedge, Carex scoparia
Rough flatsedge, Cyperus strigosus
Common rush, Juncus effusus

Forbs:
Sunflower, Helianthus spp.
Grassleaf goldenrod, Solidago graminifolia
Tall goldenrod, S. altissima
Wrinkled goldenrod, S. rugosa
Aster, Aster spp.
Maryland meadowbeauty, Rhexia mariana
Arrowleaf violet, Viola sagittata
Oldfield cinquefoil, Potentilla simplex
Honey sandvine, Ampelamelus albidus
Buckwheatvine, Brunnichia cirrhosa

5. Annual Weed Phase: Herbs (Forbs and grasses)

Arrowleaf smartweed, Polygonum saggitatum
Fall panicgrass, Panicum dichotomiflorum
Giant ragweed, Ambrosia trifida
Annual morningglory, Ipomoea lacunosa
Cocklebur, Xanthium spp.

*Dominants or subdominants characteristic of the association.

## B. BROADLEAF EVERGREEN FOREST BIOME AND ECOTONES (Southern Evergreen Forest)

### 1. OAK-MAGNOLIA ASSOCIATION

Broadleaf evergreens dominant in climax. Limited to the peninsula of Florida and southern coastal margins and islands.

| Climax | Subclimax |
|---|---|
| Southern magnolia, Magnolia grandiflora | Slash pine, Pinus caribaea |
| Laurel oak, Quercus laurifolia | Longleaf pine, P. australis |
| Live oak, Q. virginiana | Loblolly pine, P. taeda |
| Myrtle oak, Q. myrtifolia | And subclimax species of the Beech-Magnolia and Oak-Pine Ecotones |
| Devilwood, Osmanthus americana | |
| Redbay avocado, Persea borbonia | |
| Sweetbay magnolia, M. virginiana | |
| American holly, Ilex opaca | Subordinate species |
| Laurel cherry, Prunus caroliniana | Spanishmoss, Tillandsia usneoides |
| | Cabbage palmetto, Sabal palmetto |
| | Sawpalmetto, Serenoa repens |
| | Switch cane, Arundinaria tecta |

### 2. BEECH-MAGNOLIA ECOTONE ASSOCIATION

Broadleaf evergreens codominant in climax; pines dominant in subclimax or transitional phases. Restricted in extent because most soils in its climatic subregion, over the lower Coastal Plain, are too young and poorly developed to support a climatic climax.

| Climax | Subclimax |
|---|---|
| Southern magnolia, Magnolia grandiflora | Slash pine, Pinus caribaea |
| Laurel oak, Quercus laurifolia | Longleaf pine, P. australis |
| Live oak, Q. virginiana | Loblolly pine, P. taeda |
| And other species of the Oak-Magnolia Association | |
| | Winged elm, Ulmus alata |
| | Black tupelo (gum), Nyssa sylvatica |
| American beech, Fagus grandiflora | Sweetgum, Liquidambar styraciflua |
| Florida maple, Acer barbatum | And other subclimax species of the Mixed Mesophytic and Mixed Hydrophytic Associations |
| Water oak, Q. nigra | |
| And other species of the Mixed Mesophytic and Oak-Hickory Associations | |
| | Subordinate species |
| Sweetbay magnolia, M. virginiana | Spanishmoss, Tillandsia usneoides |
| American holly, Ilex opaca | Sawpalmetto, Serenoa repens |
| Inkberry holly, I. glabra | Switch cane, Arundinaria tecta |
| Laurel cherry, Prunus caroliniana | Numerous evergreen shrubs and vines |
| Southern waxmyrtle, Myrica cerifera | |

3. OAK-PINE ECOTONE ASSOCIATION

Pines codominant in the climax or dominant in a subclimax that persists because of recurring natural or manmade fires. On normal sites in its climatic subregion, over the upper Coastal Plain and Piedmont, and an edaphic climax in other regions on sites that are drier than normal, usually on immature or poorly developed soils.

| Climax | Subclimax |
|---|---|
| Post oak, Quercus stellata | Slash pine, Pinus caribaea |
| Blackjack oak, Q. marilandica | Longleaf pine, P. australis |
| Turkey oak, Q. laevis | Loblolly pine, P. taeda |
| Bluejack oak, Q. incana | Shortleaf pine, P. echinata |
| Common sourwood, Oxydendrum arboreum | [x]Virginia (scrub) pine, P. virginiana |
| Black tupelo (gum), Nyssa sylvatica | [x]Pitch pine, P. rigida |
| And other species of the Oak-Hickory Association | [x]Table-mountain pine, P. pungens |
| | Scrub (bear) oak, Q. ilicifolia |
| Myrtle oak, Q. myrtifolia | Dwarf chinquapin oak, Q. prinoides |
| Laurel oak, Q. laurifolia | |
| And other species of the Beech-Magnolia Association as subdominant or subordinate species | Sweetgum, Liquidambar styraciflua |
| | And other subclimax species of the Oak-Hickory and Mixed Mesophytic Associations |

[x]Mainly as trasitional stages in secondary succession of Oak-Hickory, Oak-Chestnut, or Mixed Mesophytic Associations.

4. PINE STAGES OF SECONDARY SUCCESSION

Within the regions of the Beech-Magnolia and Oak-Pine Ecotones, and in the southern portions of the Mixed Mesophytic, Oak-Chestnut, and Oak-Hickory Associations, one or more species of pine may dominate a stage in secondary succession on sites that support climaxes without pines. In the absence of significant amounts of other species of the Broadleaf Evergreen Forest Biome, such communities are considered as parts of the appropriate associations as indicated by the climax for each site. The pines that most often occupy this role are loblolly, shortleaf, Virginia, and pitch pine.

5. CYPRESS-TUPELO ASSOCIATION (Swamp Forest)

An edaphic climax on sites that are flooded or waterlogged most of the year.

| | |
|---|---|
| Common baldcypress, Taxodium distichum (Includes Pond baldcypress, T. d. var. nutans or var. ascendens) | Pond pitch pine, Pinus rigida var. serotina |
| | Slash pine, P. caribaea |
| Water tupelo, Nyssa aquatica | Whitecedar falsecypress Chamaecyparis thyoides |
| Swamp black tupelo, N. sylvatica var. biflora | And species of the Elm-Oak (Mixed Hydrophytic) Association |
| And subdominant or subordinate species of the Beech-Magnolia Ecotone | |

ANIMALS

For list and discussion of animal species, see Animal Ecology (Kendeigh 1961), p. 298, "Southeastern mixed biocies", and Ecology of North America (Shelford 1963), ch. 3 (pp. 63-87) and ch. 19 (pp. 474-482).

## C. NORTHERN CONIFEROUS FOREST BIOME AND ECOTONES

### 1. SPRUCE-FIR ASSOCIATION (Boreal Forest)

| Climax | Subclimax and developmental |
|---|---|
| White spruce, Picea glauca (far northern) | Jack pine, Pinus banksiana |
| Red spruce, Picea rubra | Paper birch, Betula papyrifera |
| Balsam fir, Abies balsamea | Quaking aspen, Populus tremuloides |
| | Bigtooth aspen, P. grandidentata |
| | Pin cherry, Prunus pensylvanica[x] |
| Shrubs: | Shrubs: |
| American mountainash, Pyrus (Sorbus) americana | Lowbush blueberry, Vaccinium angustifolium |
| Mountain maple, Acer spicatum | Bearberry manzanita, Arctostaphylos uva-ursi |
| Hobblebush viburnum, Viburnum alnifolium | |
| Herbs: | Herbs: |
| Bunchberry dogwood, Cornus canadensis | Checkerberry wintergreen, Gaultheria procumbens |
| Canada beadruby, Maianthemum canadensis | Hayscented cupfern, Dennstaedtia punctilobula |
| Yellow beadlily, Clintonia borealis | Common bracken, Pteridium aquilinum |
| American woodsorrel, Oxalis montana | Orange hawkweed, Hieraceum aurantiacum |
| Pyrola, Pyrola spp. | Tall buttercup, Ranunculus acris |
| Clubmosses, Lycopodium spp. | |
| Sphagnum, Cladonia, and other mosses, liverworts, and lichens | |

### 2. PINE-HEMLOCK ASSOCIATION (Lake Forest)

| | |
|---|---|
| Canada hemlock, Tsuga canadensis | Same as for Spruce-Fir Association |
| White pine, Pinus strobus | |
| Red pine, P. resinosa | |
| Shrubs: | |
| Canada yew, Taxus canadensis | |
| Fly honeysuckle, Lonicera canadensis | |

x Transitional species in secondary succession

3. SPRUCE-MAPLE ECOTONE ASSOCIATION

Conifers of Spruce-Fir Association codominant with climax dominants of Beech-Maple Association in the climax for the site.

| Climax | Subclimax and developmental |
|---|---|
| Red spruce, Picea rubra | White pine, Pinus strobus |
| Balsam fir, Abies balsamae | Red pine, Pinus resinosa |
| Fraser fir, A. fraseri (southern) | Red maple, Acer rubrum |
| Sugar maple, Acer saccharum | Gray birch, Betula populifolia |
| Americam beech, Fagus grandifolia | xJack pine, Pinus banksiana |
| Yellow birch, Betula lutea | xPaper birch, B. papyrifera |
| | xQuaking aspen, Populus tremuloides |
| | xPin cherry, Prunus pennsylvanica |
| | Shrubs and herbs of Spruce-Fir Association |

4. BEECH-HEMLOCK ECOTONE ASSOCIATION

Conifers of the Pine-Hemlock Association codominant with climax dominants of Beech-Maple Association in the climax for the site.

| Climax | Subclimax and developmental |
|---|---|
| Canada hemlock, Tsuga canadensis | White pine, Pinus strobus |
| American beech, Fagus grandifolia | Red pine, P. resinosa |
| Sugar maple, Acer saccharum | Red maple, Acer rubrum |
| American basswood, Tilia americana | Striped maple, Acer pensylvanicum |
| Yellow birch, Betula lutea | American elm, Ulmus americana |
| American hophornbeam, Ostrya virginiana | Sweet birch, Betula lenta |
| | Gray birch, Betula populifolia |
| | Black cherry, Prunus serotina |
| | xJack pine, P. banksiana |
| | xPaper birch, Betula papyrifera |
| | xQuaking aspen, Populus tremuloides |
| | xBigtooth aspen, P. grandidentata |
| | xPin cherry, Prunus pensylvanica |

| Shrubs: | Shrubs: |
|---|---|
| American mountainash, Pyrus (Sorbus) americana | Sheep laurel, Kalmia angustifolia |
| Mountain maple, Acer spicatum | Beaked hazelnut, Corylus cornuta |
| Hobblebush viburnum, Viburnum alnifolium | Scarlet elder, Sambucus pubens |
| Canada yew, Taxus canadensis | Small raspberry (thimbleberry, salmonberry), Rubus parviflorus |
| Mountain holly (winterberry), Ilex montana | Dwarf bushhoneysuckle, Diervilla lonicera |
| Fly honeysuckle, Lonicera canadensis | |
| Wandering sweetfern, Comptonia peregrina | |
| Mountain laurel, Kalmia latifolia | |
| Rosebay rhododendron, Rhododendron maximum | |

x Transitional species in secondary succession

Beech-Hemlock Ecotone Association

| Climax | Subclimax and developmental |
|---|---|
| Herbs: | Herbs: |
| Creeping partridgeberry, Mitchella repens | Hayscented cupfern, Dennstaedtia punctilobula |
| Striped pipsissewa, Chimaphila maculata | Common bracken, Pteridium aquilinum |
| American starflower, Trientalis borealis | Spinulose woodfern, Dryopteris spinulosa |
| Sarsaparilla aralia, Aralia nudicaulis | |
| Toothed woodfern, Dryopteris spinulosa | |

And other herbs of the Spruce-Fir association and Beech-Maple Association

5. LARCH-ARBORVITAE ASSOCIATION (Bog or Muskeg Forest)
Edaphic association on sites wetter than normal for the climatic region.

| Climax | Subclimax and developmental |
|---|---|
| Eastern arborvitae, Thuja occidentalis | Black ash, Fraxinum nigra |
| Eastern larch, Larix laricina | Silver maple, Acer saccharinum |
| Black spruce, Picea mariana | American elm, Ulmus americana |
| Shrubs: | Shrubs: |
| Leatherleaf, Chamaedaphne calyculata | xHazel (speckled) alder, Alnus rugosa |
| Labradortea ledum, Ledum groenlandicum | xWillow, Salix spp. |
| Bog laurel, Kalmia polifolia | xSmall cranberry, Vaccinium oxycoccos |
| Pointed mountainholly, Nemopanthus mucronata | xLarge cranberry, V. macrocarpon |
| Black chokecherry, Pyrus (Aronia) nigra | |
| Herbs: | |
| Common pitcherplant, Sarracenia purpurea | |
| Royal floweringfern, Osmunda regalis | |
| Sphagnum, and other mosses, lichens, and liverworts | |

xTrasitional species in secondary succession

ANIMALS

For list and discussion of animal species, see Animal Ecology (Kendeigh 1961), pp. 301-307, "Coniferous Forest Biome", especially "North American boreal forest biociation" and Ecology of North America (Shelford 1963), ch. 5 (pp. 123-151).

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